The Relation of Color Index to Spectrum in the Pleiades

Dr. Trumpler raises an interesting question *(Lick Obs. Bull. No. 333)* as to the behavior of color index and spectrum in the *Pleiades.* When compared with the spectral types given in the *Henry Draper Catalogue,* the values of the colors of the F and G stars are found to be abnormally low. This result appears clearly in measures by Hertzsprung[1] and by Miss Parsons,[2] as well as in unpublished data obtained at Mount Wilson by the method of exposure ratios.

The stars in question are dwarfs of absolute magnitudes 4 to 6. It is natural, therefore, to inquire, as Dr. Trumpler has done, whether the colors are not merely those usually associated with dwarf stars, which are known to be bluer than giants of the same spectral type. I am disposed, however, to believe that this is not a sufficient explanation.

Provisional values of the Mount Wilson color indices for giants and dwarfs are shown in Table I. Those in the second column refer to giants of zero absolute magnitude; for the dwarfs the colors correspond to the values of M in the last column, which are the magnitudes of highest frequency for the different spectral types. The rate of variation for intermediate values of M is illustrated by the curves shown in *Mt. Wilson Comm.* No. 59.[3] For stars of types earlier than F5 there seems to be little change in color with absolute magnitude. The A5 stars possibly show some variation, but the difference can be ignored here. From F0 on the spectral classification is that used at Mount Wilson; for the earlier types the results are based on bright stars classified at the Harvard Observatory. Although the difference in color for giants and dwarfs in the region G5-K5 is considerable, it appears that in the interval F0-G5, where the abnormal relation makes its appearance in the case of the Pleiades, the influence of luminosity is small, if not actually zero.

The data in Table I refer to the color system of the reflector; but this circumstance offers no complication, as may be seen

[1] Quoted by Trumpler.
[2] *Ap. Jour.,* **47**, 42, 1918.
[3] *Proc, Nat. Acad. of Science,* **5**, 232, 1919.

from Table II, which gives, in hundredths of a magnitude, the color indices found by Miss Parsons, Hertzsprung, and myself corresponding to the spectral types of the *Henry Draper Catalogue*. The quantities in parentheses indicate the approximate weight. The color systems of the three observers are practically identical; hence the mean color indices are directly comparable with the Mount Wilson values for the colors of the stars at large. The latter, in the fifth column, have been interpolated from Table I, and beyond F5 refer to dwarf stars. Although the comparison is between dwarfs, the differences in the last column of Table II show clearly the anomaly in question.

TABLE I

Mount Wilson Color Indices
Color System of 60-inch Reflector

Sp.	C. I. M = 0	Dwarfs C. I.	Dwarfs M
B0	−0.32		
B5	−0.17		
A0	0.00		
A5	+0.19		
E0	0.38		
F5	0.62	+0.62	3.3
G0	0.86	0.72	4.4
G5	1.15	0.83	5.2
K0	1.48	0.99	5.9
K5	1.84	1.26	7.1
Ma	1.88	1.76	9.8
Mb	(+1.88)	(+2.00)	(11.0)

TABLE II

Comparison of Colors of Pleiades
With M. W. Color System

Sp.	Pleiades Parsons	Pleiades Hertzsprung	Pleiades Seares	M W Color System	M W minus Pleiades
B5	−15 (6)	−18 (1)	−21 (6)	−17	+ 1
B8	−18 (6)	−14 (6)	−12 (4)	− 7	+ 8
B9	− 7 (7)	−11 (6)	− 3 (6)	− 3	+ 4
A0	+8 (14)	+ 2 (11)	+ 9 (8)	0	− 6
A2	+15 (5)	+13 (15)	+14 (4)	+ 7	− 7
A3	+19 (3)	+14 (15)	+18 (3)	+11	− 4
A5	+ 7 (1)	+16 (12)	+ 8 (1)	+19	+ 5
F0	+31 (1)	+19 (10)	+14 (1)	+38	+18
F5	+30 (1)	+20 (10)	.....	+62	+41
F8	+24 (3)	+23 (12)	+22 (2)	+68	+45
G0	+33 (2)	+26 (15)	+30 (2)	+72	+45
G5	+47 (1)	+37 (26)	.....	+83	+46

The colors of the F5-G5 stars in the *Pleiades* may deviate from those of other dwarfs, but a partial explanation at least

seems to lie in another suggestion made by Dr. Trumpler, namely, systematic errors in spectral classification. The stars concerned are faint, ranging from the 9th to the 11th photographic magnitude; the classification therefore depends on low-dispersion spectrograms, and the conditions are thus favorable for the appearance of an error depending on magnitude. The Mount Wilson color indices for the stars at large, on the other hand, were derived from bright objects whose spectra are easily and accurately determined.

That a magnitude error in the spectral types actually enters is suggested by the group of A0 *Pleiades,* which extends over the interval 6.7-9.0. The results of the three observers are here again in agreement in showing a gradual and nearly parallel increase in color index with magnitude, amounting to about 0.2 mag. This apparently is to be attributed to increasing difficulty of classification, since for A0 stars in general there is no evidence of a dependence of color upon luminosity. A similar result is found also for the B9 group, and is at least suggested in the case of the A2 stars; but for the latter the range in magnitude is too small to make the change in color conspicuous. The B5 and B8 stars are all brighter than 6.5, so that a magnitude effect is scarcely to be expected, and in fact does not appear.

The large positive differences in the last column of Table II cannot be entirely due to errors in the color indices, for although the values in Table I are provisional, there is ample evidence that they are not far from the truth. The differences in question correspond to a spectral interval or more, and are very similar to those appearing in Schwarzschild's comparison[4] of the *Revised Harvard Photometry* with Miss Cannon's results for 1477 stars in *Harvard Annals,* **56**, IV.

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Discovery of Bright Hydrogen Lines in the Spectrum of the Variable Star W Cephei

In carrying out the program for the detection of a bright Hα line in B type stars, undertaken by Mr. Merrill and the

[4] *Göttinaen Aktinometrie,* B, pp. 19, 21.